REMARKS

Claims 1, 3-26, 37-42, and 45-50 are currently pending. By the present amendment, Claims 1, 20, 21, 38, and 39 have been amended, Claims 4-17 have been canceled, and new Claims 51-56 have been added. Support for the amendment is found in the specification and claims as filed. Upon entry of the present amendment, Claims 1, 3, 18-26, 37-42, and 45-56 will be under consideration.

Claim Rejections - 35 U.S.C. § 112, first paragraph

Claims 1, 3-26, 37-42, and 45-50 have been rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement as to the phrase "wherein the third layer is of a homogeneous porosity." Although Applicants do not necessarily agree with the propriety of the rejection, Claim 1, from which the remaining claims depend, has been amended to delete this limitation. Accordingly, Applicants respectfully request withdrawal of the rejection.

Claim Rejection - 35 U.S.C. §103(a) - Yamada et al. in view of Berger et al.

Claims 1, 3-25, 37-42, 45-47, and 50 have been rejected under 35 U.S.C. §103(a) as obvious over Yamada et al. (U.S. 5,331,180) in view of Berger et al. ("Porosity superlattices: new class of Si heterostructure"). It is well settled that the Examiner "bears the initial burden of presenting a *prima facie* case of unpatentability..." *In re Sullivan*, 498 F.3d 1345 (Fed. Cir. 2007). Until the Examiner has established a *prima facie* case of obviousness, the Applicant need not present arguments or evidence of non-obviousness. To establish a *prima facie* case of obviousness, the Examiner must establish at least three elements. First, the prior art reference (or references when combined) must teach or suggest all of the claim limitations: "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 165 U.S.P.Q. 494, 496 (CCPA 1970); *see also M.P.E.P. § 2143.03*. Second, there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 800 F.2d 1091 (Fed. Cir. 1986); *see also M.P.E.P. § 2143.02*. And finally, the Examiner must articulate some reason to modify or combine the cited references that renders the claim obvious. Merely

establishing that the claimed elements can be found in the prior art is not sufficient to establish a *prima facie* case of obviousness:

> As is clear from cases such as *Adams*, a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (2007) (emphasis added).

Instead, the Court has made clear that the Examiner must establish a reason one of skill in the art would have combined the elements of the prior art, and that such reason must be more than a conclusory statement that it would have been obvious.

> Often, it will be necessary for a court to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. To facilitate review, this analysis should be made explicit. *See In re Kahn*, 441 F.3d 977, 988 (C.A.Fed.2006) ("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness"). *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1740-1741 (2007).

Applicants respectfully submit that the pending claims as amended are not obvious under 35 U.S.C. § 103(a) for the reasons detailed below.

Pending Claim 1 as amended, from which the remaining claim depend, recites "[a] photovoltaic device, the device comprising: a first layer comprising an amorphous silicon semiconductor material of n-type conductivity; a second layer comprising a crystalline silicon semiconductor material of p-type conductivity; and a third layer comprising a non-doped semiconductor material, wherein the third layer is situated between and contacts the first layer and the second layer, and wherein the third layer is a translucent porous layer and diffusion barrier having a thickness of from about 1 nm to about 50 nm."

The devices of Yamada et al. and Berger et al. are light emissive devices, in contrast to the photovoltaic devices as recited in the claims. As discussed in the attached Declaration of Dr. Jeff Poortmans, a photovoltaic device converts light into electricity, whereas a light emissive device converts an electrical signal into emitted light. The function of a porous layer in both types of devices (photovoltaic versus photoemissive) is different, therefore the thickness of the

porous layer in both types of devices is substantially different – the thickness of the porous layer is not just a matter of design choice. With respect to light emitting devices, it is known that silicon has an indirect band gap and is generally not considered to be suitable for use in light emitting devices. Therefore porous silicon is used as a layer for converting an electrical signal into light. For example, in Yamada et al. [see col. 8, lines 18 to 35] it is explained that a radiative mechanism is obtained through the use of porous fine wires. When a voltage is applied over the LED structure, avalanche breakdown occurs within the quantum wire cluster (i.e., the porous silicon) to generate electron-hole pairs; through recombination of the electron-hole pairs, visible light is radiated from the quantum wires. Because the light generation occurs in the porous layer, a relatively thick porous layer, namely, a layer having a thicknes of 100 to 1000 nm, is preferred. Contrary to assertions in the Office Action, it is not correct to say that Berger et al. teaches a porous layer having a thickness of 20 nm. As discussed in the Declaration of Dr. Jef Poortmans, Berger et al. teaches the use of superlattices as a filter which can be used to narrow the broad luminescence spectrum of porous silicon. This narrowing of the spectrum would not be obtained with a porous layer having a thickness as in the device of the pending claims, but can only be obtained only with a much thicker superlattice comprising a periodic porosity variation.

Applicants' device as claimed is a photovoltaic device, e.g., a HIT (Heterojunction with Intrinsic Thin-layer) cell. The device as claimed has a second layer comprising a crystalline semiconductor material, a first layer comprising an amorphous silicon semiconductor material which forms a heterojunction with the second layer, and a third layer comprising a porous, non-doped (intrinsic) semiconductor material. This is the structure of a HIT (Heterojunction with Intrinsic Thin layer) cell. As discussed in Example 1 of our application as filed, a comparative example, a photovoltaic cell structure wherein the third layer is an intrinsic amorphous silicon layer is known in the art. It is known in the art that the incorporation of such an intrinsic amorphous silicon layer improves the properties of the heterojunction via reduction of carrier recombination. In our device as presently claimed, replacing the intrinsic amorphous layer by a porous layer offers superior properties and advantages when compared to prior art devices. One advantage is that the porous layer also acts as a barrier layer (e.g., against indium diffusion). The porous layer also exhibits less light absorption than an intrinsic amorphous silicon layer. As illustrated in Figures 3 to 6, of our application as filed, using a porous layer instead of an intrinsic

amorphous silicon layer results in superior photovoltaic cell properties, especially for very thin porous layers (e.g., a 24 nm or 26 nm thin porous layer exhibits superior properties, but the results for a 16 nm thin porous layer are even better still). Excellent results are obtained for porous Si layers with a very low porosity of 15-20% and the thickness in the range of 5-10 nm as measured by spectroscopic ellipsometry.

The Office Action asserts that the thickness of the porous layer is merely a matter of design choice. In *Gardner v. TEC Systems, Inc.*, 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), *cert. denied*, 469 U.S. 830, 225 USPQ 232 (1984), the Federal Circuit held that, where the only difference between the prior art and the claims was a recitation of relative dimensions of the claimed device and a device having the claimed relative dimensions would not perform differently than the prior art device, the claimed device was not patentably distinct from the prior art device. Unlike in *Gardner*, the thickness of the porous layer in Applicants' device is critical to the photoconductive properties of the device. A relatively thick porous layer as in Yamada et al. and Berger et al. is suitable for use in a photoemissive device, but is undesirable in a photovoltaic device such as the one claimed by Applicants.

Moreover, the thickness of the porous layer is not a matter of routine optimization either. Only result effective variables can be optimized. MPEP § 21444.05 II B. A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation. *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977) (The claimed wastewater treatment device had a tank volume to contractor area of 0.12 gal./sq. ft. The prior art did not recognize that treatment capacity is a function of the tank volume to contractor ratio, and therefore the parameter optimized was not recognized in the art to be a result-effective variable.). Neither Yamada et al. nor Berger et al. recognize the effect of thickness of the porous layer on effectiveness of a device as a photoconductor. To the contrary, one would select a thick porous layer based on the teachings of the cited art, because thick porous layers are desirable in photoemissive devices.

Accordingly, Applicants respectfully request that the rejection of the claim be withdrawn.

Claim Rejection - 35 U.S.C. §103(a) - Yamada et al. in view of Berger et al. and Suzuki et al.

Claim 26 has been rejected under 35 U.S.C. §103(a) as obvious over Yamada et al. in view of Berger et al. and further in view of Suzuki et al. ("U.S. 5,644,156"). The criteria for establishing a *prima facie* case of obviousness are set forth above, as are the limitations of Claim 1, from which Claim 26 depends, and the teachings of Yamada et al. and Berger et al. As discussed above, Yamada et al. and Berger et al. do not teach or fairly suggest Applicants' photovoltaic device as claimed. Suzuki et al. is cited for teaching a layer comprising macro etch pits, as well as layers having p-type and n-type conductivity; however, Suzuki et al. does not overcome the deficiencies of Yamada et al. and Berger et al. in that it also relates to porous silicon layers for use in light emissive devices. The light emissive device comprising the porous silicon layer is used, e.g., as a photocoupler for a pin photodiode. The structure of the pin photodiode (the only photovoltaic device disclosed in Suzuki et al.) is not described. Accordingly, Applicants respectfully request that the rejection of the claims be withdrawn.

Claim Rejection - 35 U.S.C. §103(a) - Yamada et al. in view of Berger et al. and Fonash et al.

Claims 48 and 49 have been rejected under 35 U.S.C. §103(a) as obvious over Yamada et al. in view of Berger et al. and further in view of U.S. 6,399,177 ("Fonash et al."). The criteria for establishing a *prima facie* case of obviousness are set forth above, as are the limitations of Claim 1, from which Claims 48 and 49 depend, and the teachings of Yamada et al. and Berger et al. As discussed above, Yamada et al. and Berger et al. do not teach or fairly suggest Applicants' photovoltaic device as claimed. Fonash et al. is cited for teaching a porous structure made of silicon, germanium and carbon; however, Fonash et al. does not overcome the deficiencies of Yamada et al. and Berger et al. in that it includes no disclosure as to a photovoltaic device comprising such a layer. Accordingly, Applicants respectfully request that the rejection of the claims be withdrawn.

Conclusion

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is in condition for allowance. Should the Examiner have any remaining concerns that might prevent the prompt allowance of the application, the Examiner is respectfully invited to contact the undersigned at the telephone number below.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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